EXTENDED MOBILITY

RUBY HADLEY

HARAMBEE >>> PULLING TOGETHER

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EXECUTIVE SUMMARY

What is this project all about?

Increasing Mobility in Uganda

The basis of this project is mobility, something many of us take for granted in our daily lives. It is hard to imagine what life would be like if not only were we mobility impaired, but also living on as little as a dollar a day. In rural Uganda, this is often a reality that many live with. It is for this reason that I have found myself working on the Harambee Project as I see a chance to make discoveries and possibly even make a difference to this situation. It is an opportunity to work with people who are living in this reality and see what empowering solutions can be found in such a partnership.

As a team of four students, the Harambee project explores different facets of mobility in Uganda and what it means to the people living there. My specific area of focus is utilizing the current manufacturing capabilities to translate the North American rolling walker into the rural Ugandan context.

Currently, there is a huge need for wheelchair tricycles as a large percentage of the Ugandan population live with severe disabilities. However, these wheelchairs, as cost efficient as they may be for a North American market, are still not attainable to most people that need them in Uganda. On top of this, there is a large amount of people who perhaps do not need as complex a vehicle as a wheelchair and could benefit from a less expensive, simpler and smaller, mobility aide. Through my research, conceptualization and final designs, a context-specific solution came together through collaboration with local users.

An Opportunity in a New Market

Rolling walkers are a prominent and popular option for people with disabilities in North American and European markets, but such a device does not exist in the African market. A large reason for this is the terrain seen in rural Africa, where people could benefit most from a walking aide, as it is rugged and most typical rolling walkers would fail to withstand it. Secondly, current designs of rolling walkers use materials that are not easily attainable in Africa, and are therefore much too expensive for this context. There is an opportunity here to develop an appropriate redesign for the rural African market, starting in Uganda.

> "It's estimated that 20 million people living in developing countries need wheelchairs"

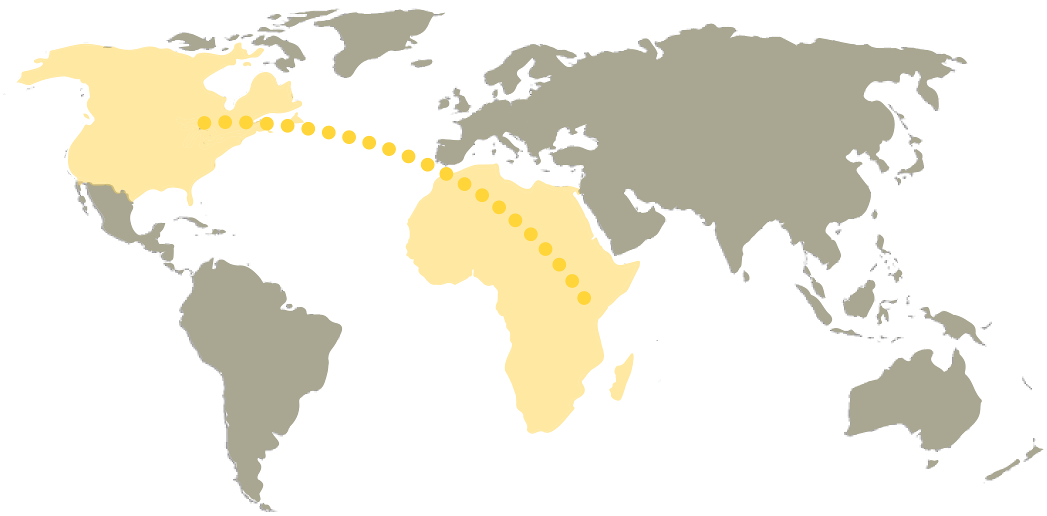
Testing and Research to Final Design

Through research of the environment, target users, market analysis of current rolling walkers, and most importantly working together with the people in Uganda who could benefit from a walking aide, a clear understanding of the project direction can be obtained. In considering simple manufacturing methods, locally sourced materials and overall low cost as the overarching measures of success, the goal of this project is to develop a walking aide specifically for the situation in rural Uganda.

"Of Uganda's 33 million, 16%, well over 5 million of the population live with disabilities"

RESEARCH

Background



Project Partners and Beginnings

Due to years of civil war in Uganda, along with the misfortunes of poverty and poor health care, there is a significantly high percentage of people with disabilities in the country. The Harambee Project spurred from a partnership between CanUgan, an organization advocating for people with disabilities in Uganda, and Carleton University's School of Industrial Design to address this situation. With funding support from the International Development Research Center of Canada, the project began with the aim to co-create innovative solutions for people with disabilities in the rural village of Kasese in Uganda. The key to this partnership is *co-creation*. In working together with locals who have disabilities, more comprehensive and appropriate solutions can be found and in turn benefit those who need it the most.

Exploring the Rolling Walker

In the research phase of this project, the North American rolling walker was dissected based on the main features that render it a successful product in this context. In parallel, the requirements of a rural Ugandan user, a person with mild disabilities, was explored through building personas and scenarios. This exploration helped to illustrate the reason behind why walkers are so popular in North America and Europe, but are rare in Africa despite the amount of people that could benefit from them. This disconnect between product and user was the basis for translating what we know works in our North American environment to something that is appropriate for a completely new environment unfamiliar with rolling walkers as an assistive device.

“87% of the Ugandan population live in rural areas & 75 % of the population lives on less than 2$ a day”

“In rural villages, you must learn to live on little and make every shilling count”

RESEARCH

Disconnect Between Product & User

	AN EXISTING WALKER OFFERS... (Low → High)		A UGANDAN USER REQUIRES... (Low → High)
COST	● ● ● ● ●	**COST**	● ○ ○ ○ ○
RIGIDITY	● ● ○ ○ ○	**RIGIDITY**	● ● ● ● ●
MANUFACTURING	● ● ● ● ●	**MANUFACTURING**	● ○ ○ ○ ○
COLLAPSIBILITY	● ● ● ● ●	**COLLAPSIBILITY**	● ● ○ ○ ○

Understanding the North American rolling walker was a much simpler task than understanding the rural Ugandan walker user as information to breakdown the walker was relatively accessible. I contacted a local rollator manufacturer and distributer, Dana Douglas, and got a wealth of insights that aided with the process. Uncovering the needs of the product's users, however, was built on a fair amount of assumption until a conference in November was held with our partners in Uganda.

The disconnect between product and user came into four main categories: cost, rigidity, manufacturing, and collapsibility. As illustrated in the diagram above, the existing product offers quite the opposite of what the user requires. A high cost, complexly manufactured, and low-rigidity rolling walker is not appropriate for a user who has a low income, and required a strong product to withstand rugged terrain. On top of this, when living in poverty, an assistive device is a huge investment they make in their mobility.

RESEARCH

User Interview: Conference with Kasese

In order to further understand the cultural environment and the situational context, an interview conference was held to set in motion the relationship with our partners in Kasese. This conference included members of KADUPEDI, the tricycle wheelchair manufacturer, Kio, and two experts in the field from San Francisco, Noel Wilson and Aaron Wieler.

The Harambee team asked many questions about the overall environment and the typical users to those in Kasese to gain a better understanding. Following this, we went into more specific questions to further focus our directions which helped clear up many assumptions we had made.

What are the most difficult areas of the tricycle to manufacture?

The brake system, and joining sprocket and chain together, ensuring wheel alignment

What tools are used the most in the manufacturing process?

Welding machine, locally made pipe bender and table vice

Could people using the tricycle benefit from a smaller vehicle?

People with disabilities get around by crawling, and they sit on chairs when they are not in the trike but what about others? How could designs benefit other people with disabilities?

> “ My bike’s design has improved 85% over time ”
>
> - Kio on how he feels about his tricycle

“The product must fit the user properly in order to be fully beneficial to them”

RESEARCH

Investigating the Product

Dana Douglas Site Visit

After initial research on what was types of rolling walkers were on the market in North America, I had a better understanding of the background of sizing, weight, frame design, and price point. With this information, I visited Dana Douglas, a local rollator manufacturer and distributor to get insights on what factors needed to be considered in a rural Ugandan context based on what were important factors here.

Doug MacMillan from Dana Douglas clarified many key areas that could not be overlooked, such as frame weight, width and height, wheel size, seat height, the type of brake system and collapsibility. He also donated several rollators that were used for studying, used for spare parts, and testing in Uganda.

DESIGN GUIDELINES

Context-Specific Measures of Success

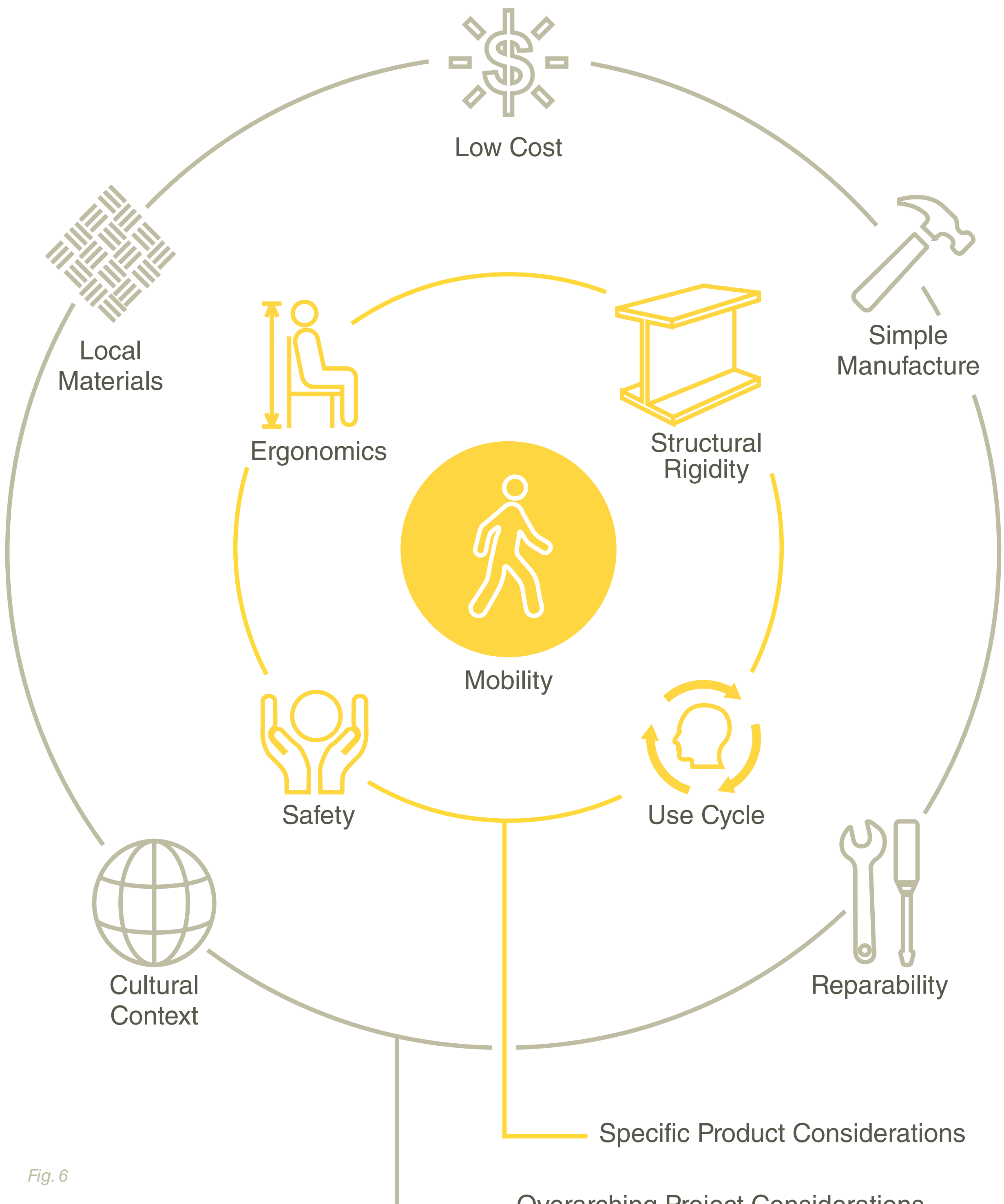


Fig. 6

DESIGN GUIDELINES

Context-Specific Measures of Success

Low cost: The product can be manufactured and sold for under $100 USD.

Simple Manufacture: Manufacturing techniques are simple enough (90° bends, one plane) and require minimum technology, allowing it to be made locally by Kio as well as other manufacturers. These techniques would follow similar processes used for the tricycle wheelchair currently being produced.

Local Materials: 75% of the product's parts can be locally sourced in Kasese, while more specific parts are sourced from the nearest city center.

Reparability: Though designed to withstand wear and tear, if the product breaks down, it can be easily and locally serviced.

Cultural Context: The design of the product matches the values, beliefs and overall culture of the environment.

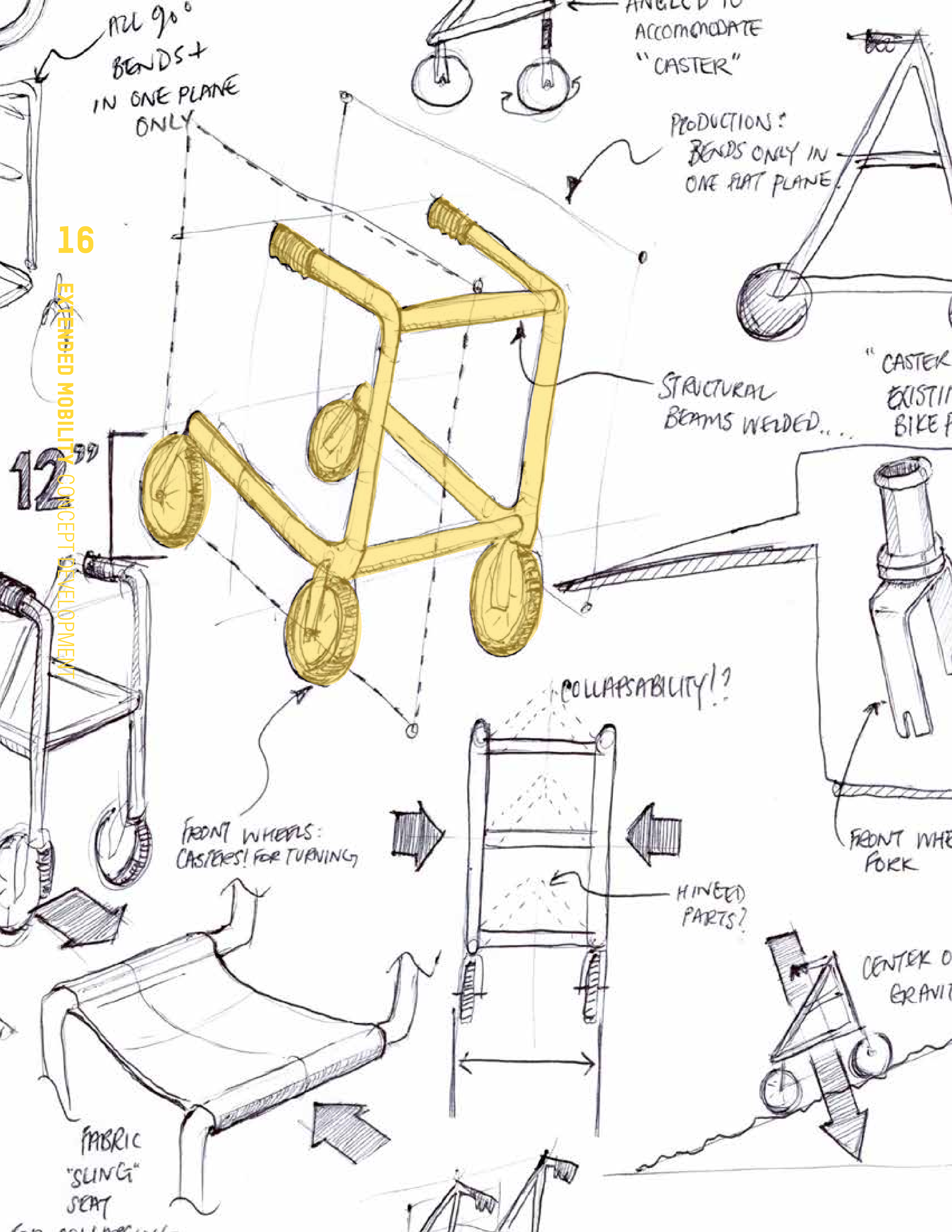
Use Cycle: The product is intuitive and simple to use from the basic action of moving forward to turning, going up and down hill, reversing, braking, and getting in and out of the seat.

Safety: The design includes features that ensure the safety of the user during mobility and while seated. This will be based mainly on the stability and balance of the structure, along with the brake system.

Ergonomics: The manufacture of the design considers the different sizes of users and is comfortable to use in terms of handle height, seat height, brake pressure and overall weight.

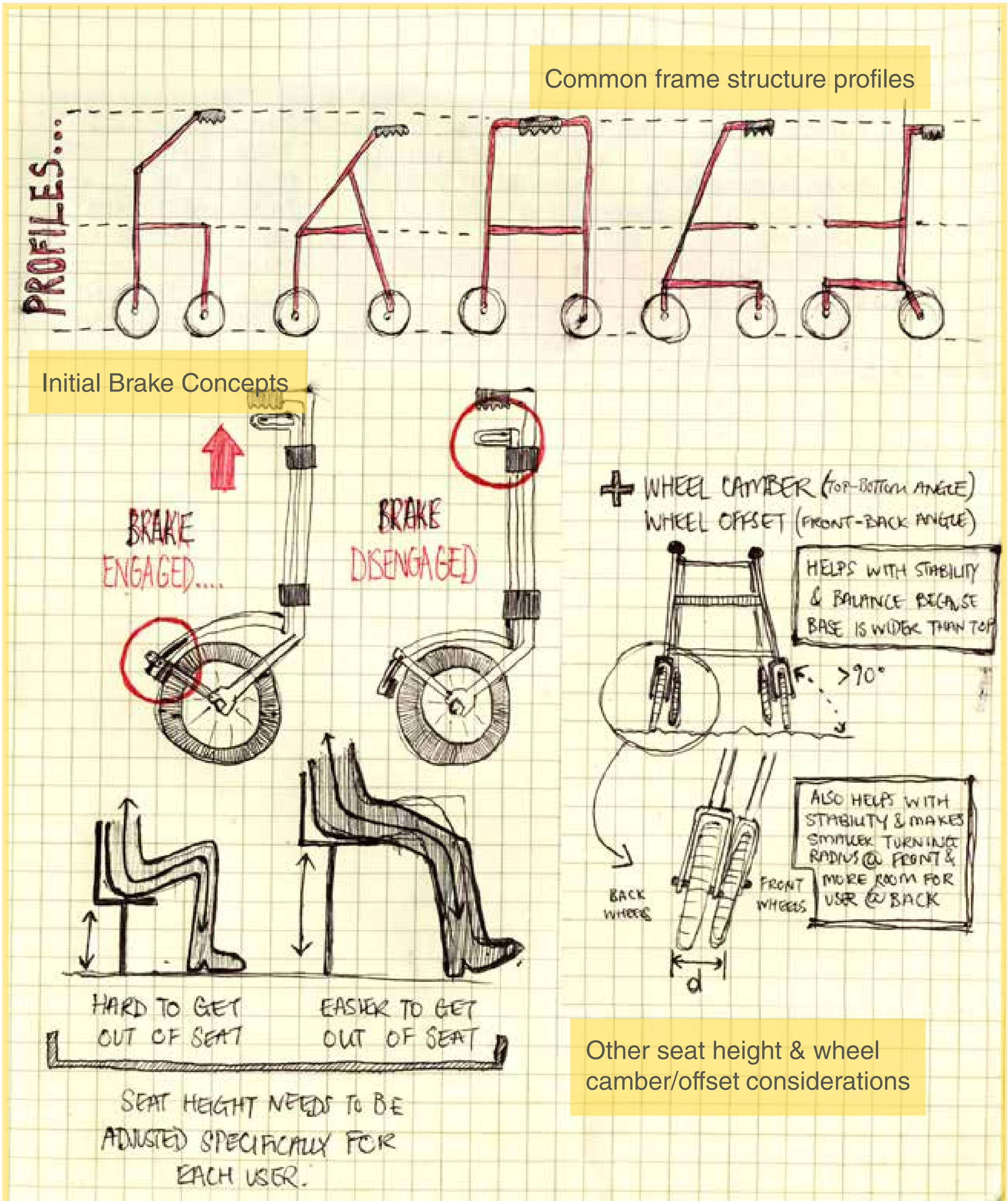
Structural Rigidity: The product is structurally sound and can withstand the rugged terrain of the environment so it will require as few tune ups and repairs as possible.

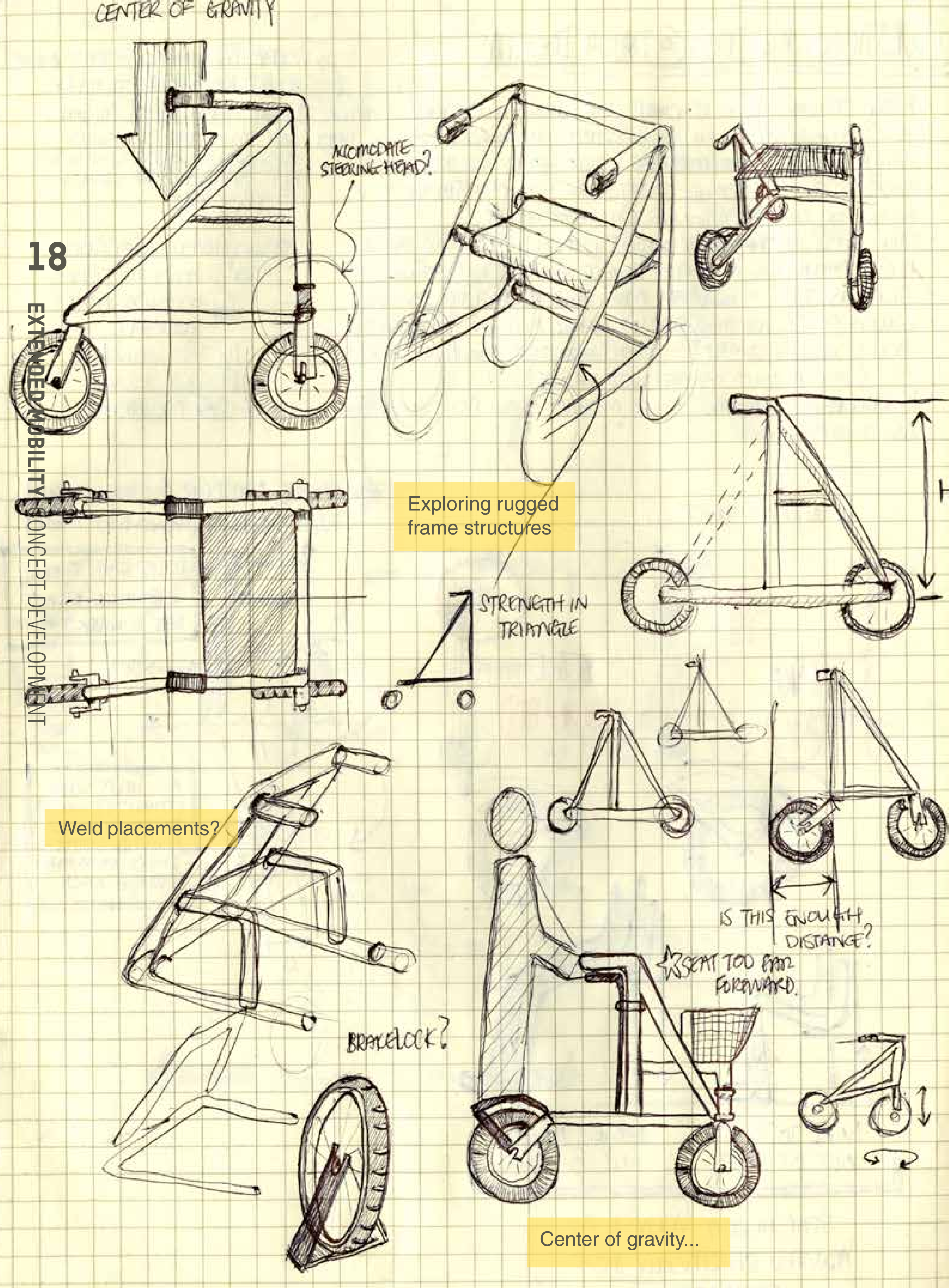
Fig. 7


ALL 90°
BENDS +
IN ONE PLANE
ONLY
ACCOMMODATE
"CASTER"
PRODUCTION:
BENDS ONLY IN
ONE FLAT PLANE
STRUCTURAL
BEAMS WELDED...
12"
COLLAPSABILITY!?
FRONT WHEELS:
CASTERS! FOR TURNING
HINGED
PARTS?
FABRIC
"SLING"
SEAT
CENTER OF
GRAVITY
FORK

CONCEPT DEVELOPMENT

Formal and Mechanical Exploration

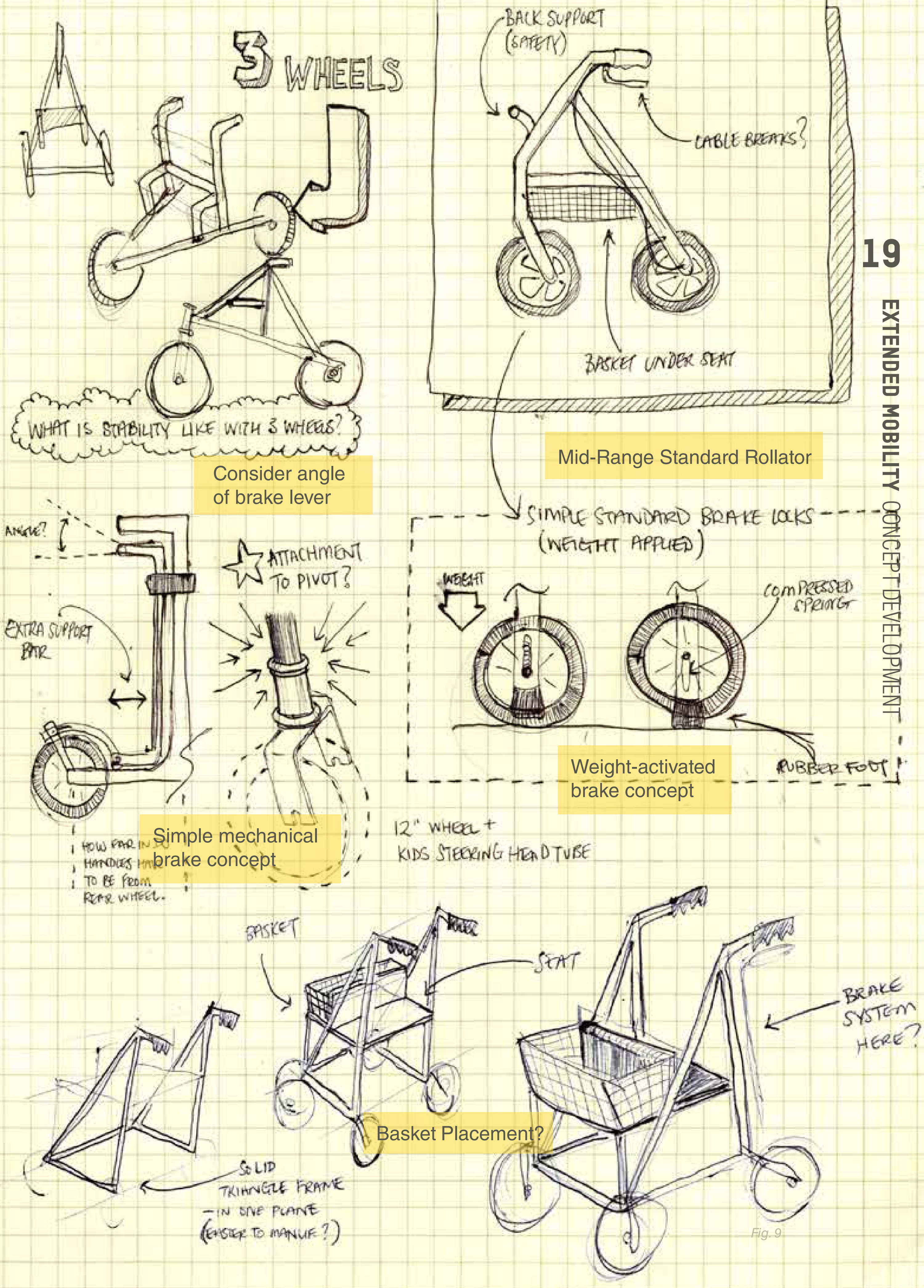




Exploring rugged frame structures

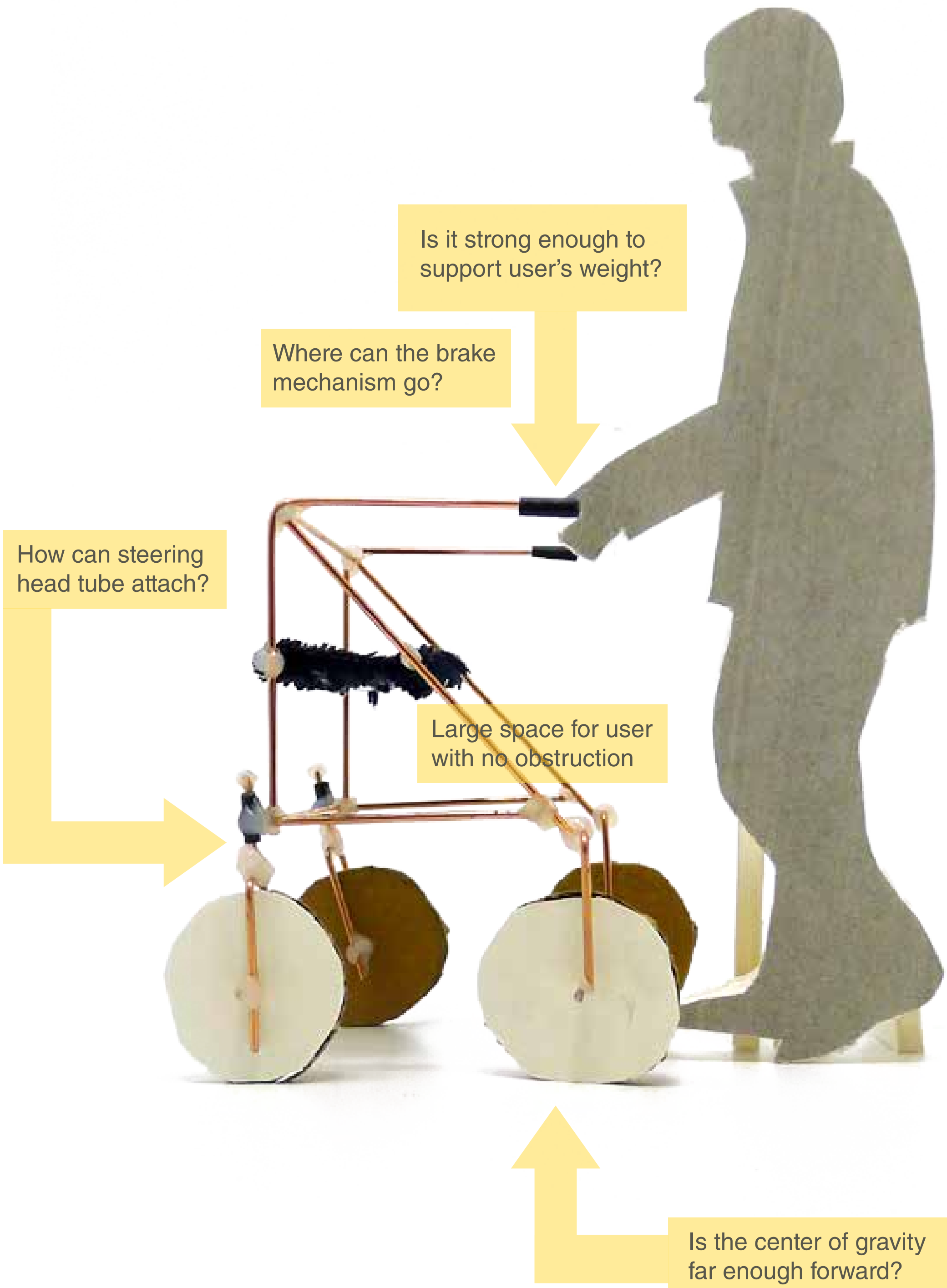
Weld placements?

Center of gravity...


3 WHEELS
WHAT IS STABILITY LIKE WITH 3 WHEELS?
BACK SUPPORT (SAFETY)
CABLE BREAKS?
BASKET UNDER SEAT
Mid-Range Standard Rollator
Consider angle of brake lever
ANGLE?
ATTACHMENT TO PIVOT?
EXTRA SUPPORT BAR
SIMPLE STANDARD BRAKE LOCKS (WEIGHT APPLIED)
WEIGHT
COMPRESSED SPRING
RUBBER FOOT
Weight-activated brake concept
Simple mechanical brake concept
12" WHEEL + KIDS STEERING HEAD TUBE
BASKET
SEAT
BRAKE SYSTEM HERE?
Basket Placement?
SOLID TRIANGLE FRAME — IN ONE PLANE (EASIER TO MANUF?)
Fig. 9

CONCEPT DEVELOPMENT

Formal and Mechanical Explorations



CONCEPT DEVELOPMENT

Formal and Mechanical Explorations

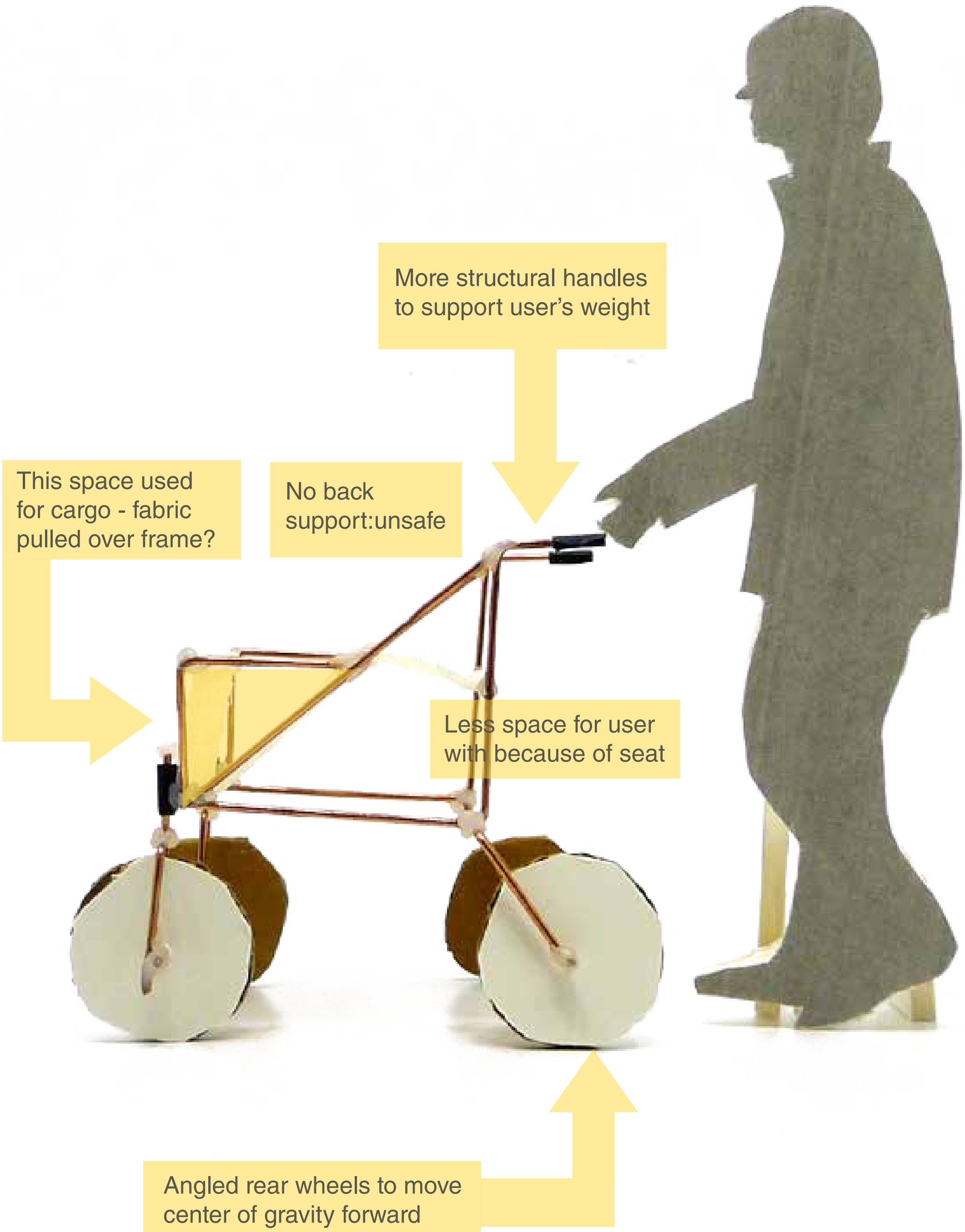
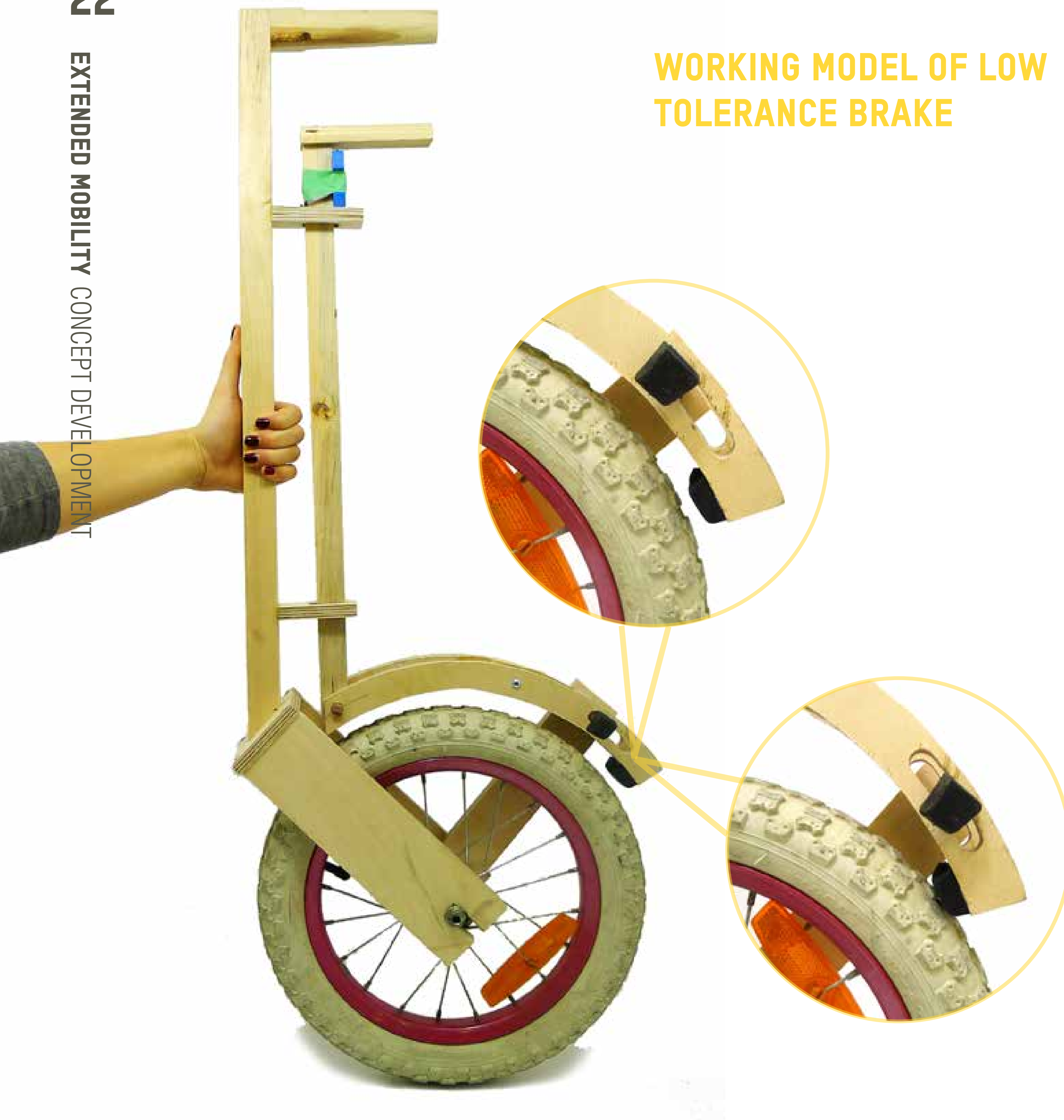


Fig. 10

CONCEPT DEVELOPMENT

Formal and Mechanical Explorations



WORKING MODEL OF LOW TOLERANCE BRAKE

CONCEPT DEVELOPMENT

Formal and Mechanical Explorations

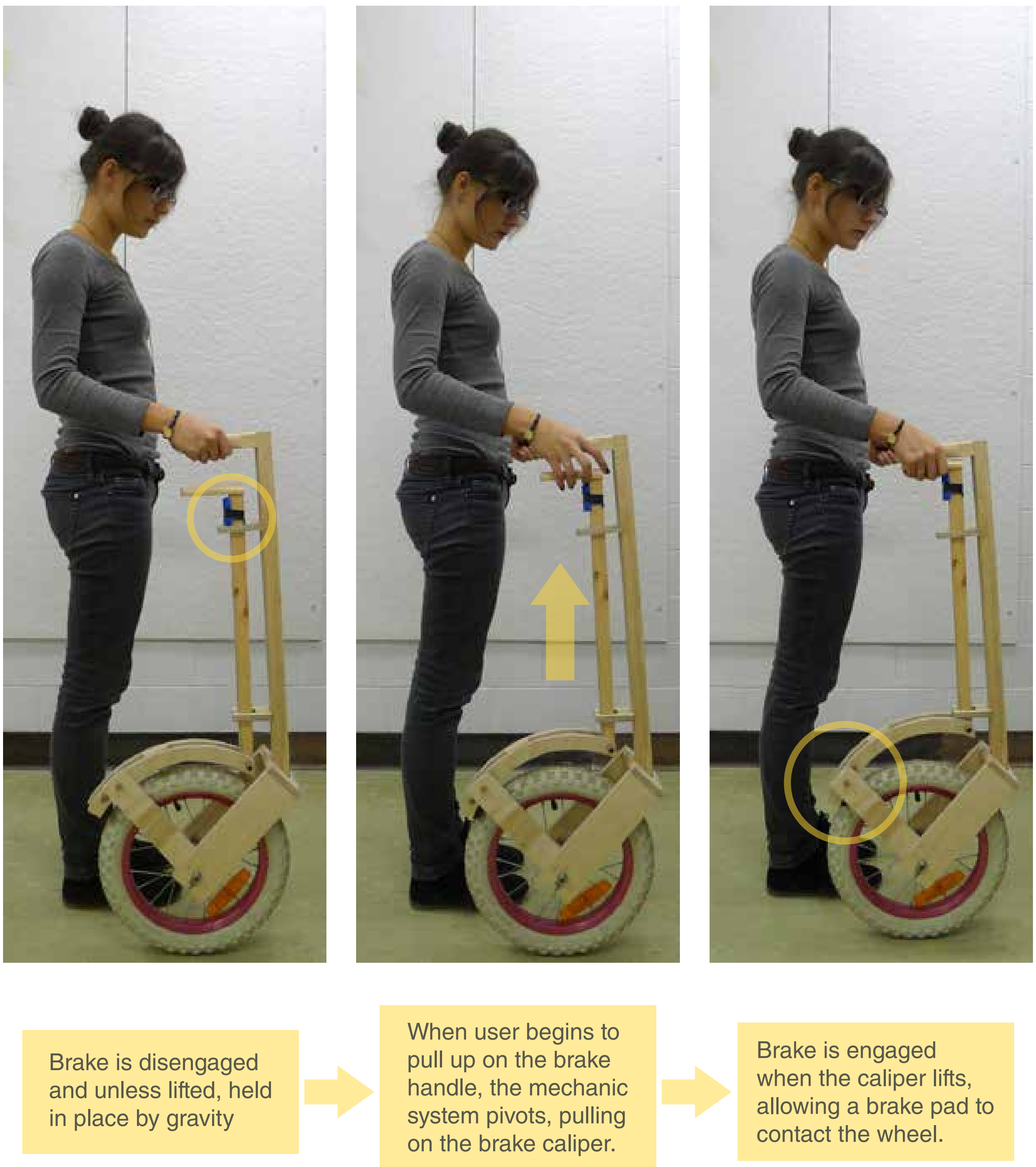
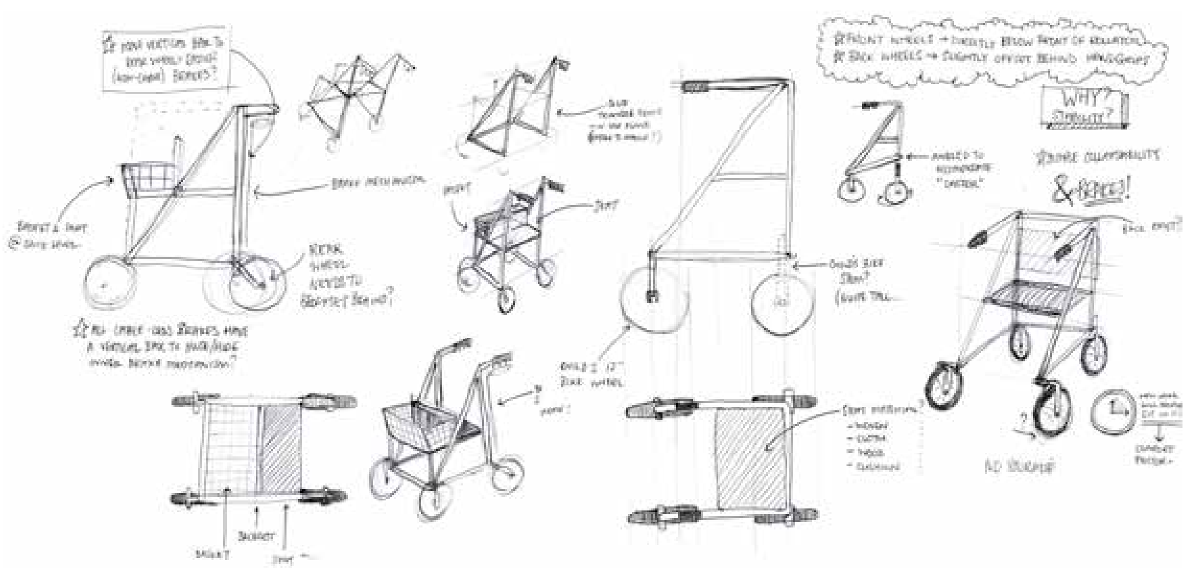


Fig. 11

CONCEPT DEVELOPMENT

Initial Prototype Prior to Field Testing

Initial frame designs were prototyped before a full scale model was fabricated. Using the information from the Kasese Skype Conference, visit to Dana Douglas and the rest of the research, I had an idea of what was required from the frame design. The first concept was a welded steel frame, built in flat planes with only 90° bends to keep manufacturing simple. The rear wheels were 12" bike tires, which could be sourced in Uganda, and are more appropriate for tackling rough terrain. The overarching metrics were low cost, local materials, and local, simple manufacture.



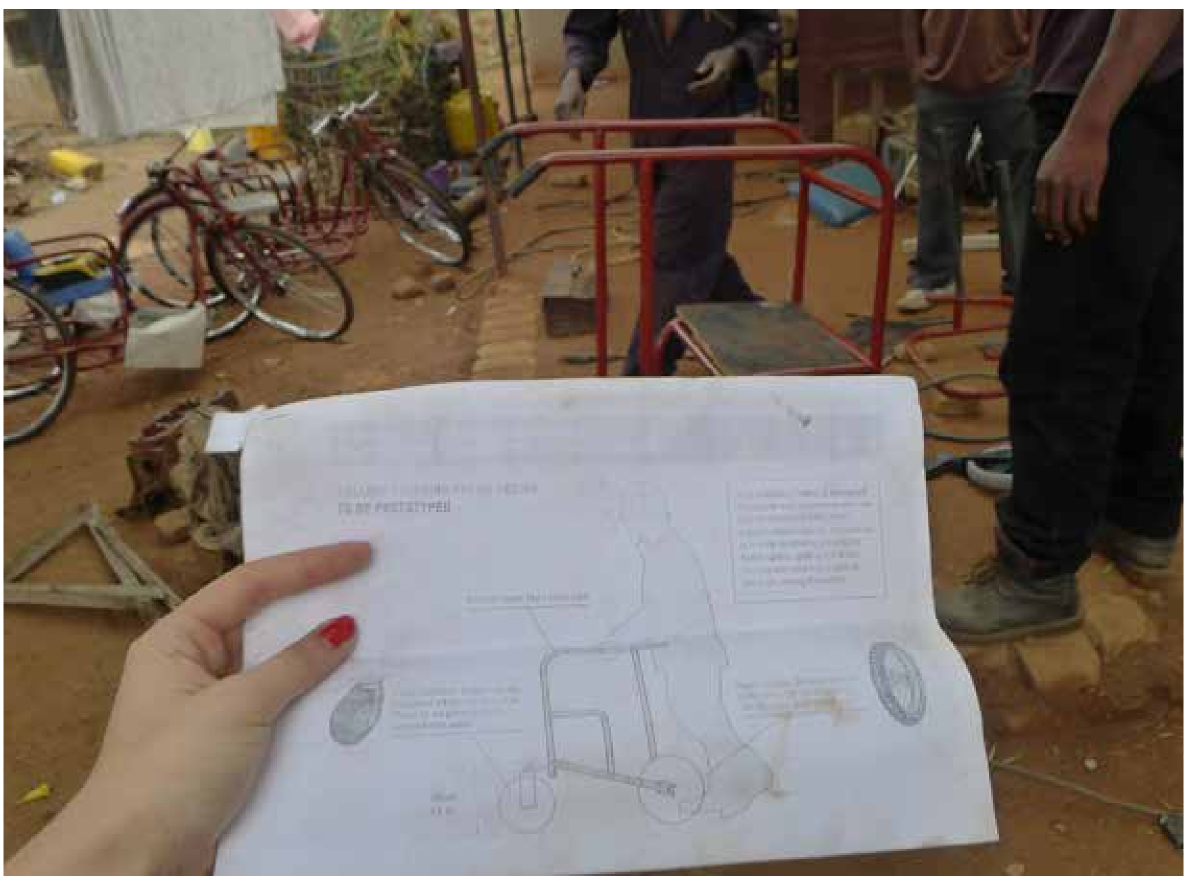

LOCAL MANUFACTURE
LOCAL MATERIALS
LOW COST

FIELD TESTING IN UGANDA

Cross-Cultural Communication

Beyond the initial prototype, there were still many questions to be answered in terms of the specific Ugandan environment. Designing without being familiar with the context left many assumptions needing clarification. An important step in the development of the project was initiating a relationship with our partners in Kasese, beginning with our local manufacturer, Kio. A drawing package (see right) was composed with the details of the initial design made in Canada. Only critical dimensions were included to allow for freedom in the manufacturing stage. This was a test in cross-cultural communication to see how well the design could be understood and how it would be interpreted once built.

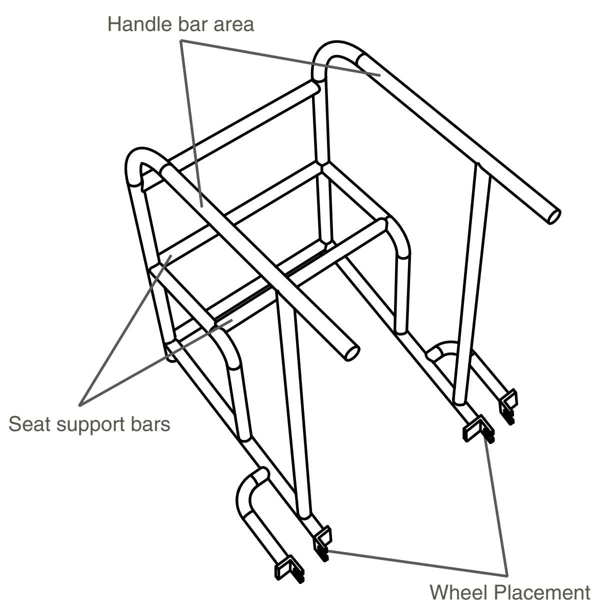
Upon arrival in Kasese, Kio presented the walker frame he built from my drawings. The test of communication was a big success, as there were only a few minor changes that he made. The reasons behind these changes provided further insight into the frame's design and development.

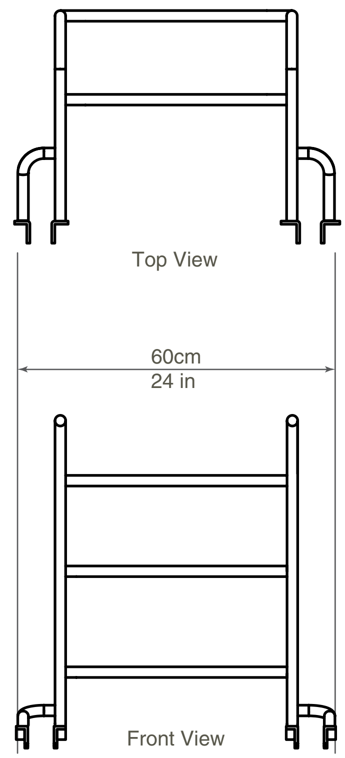


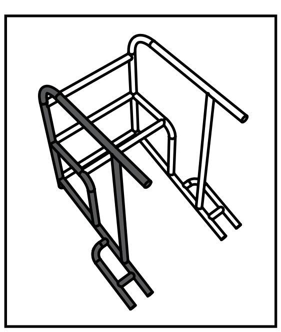
FIELD TESTING IN UGANDA

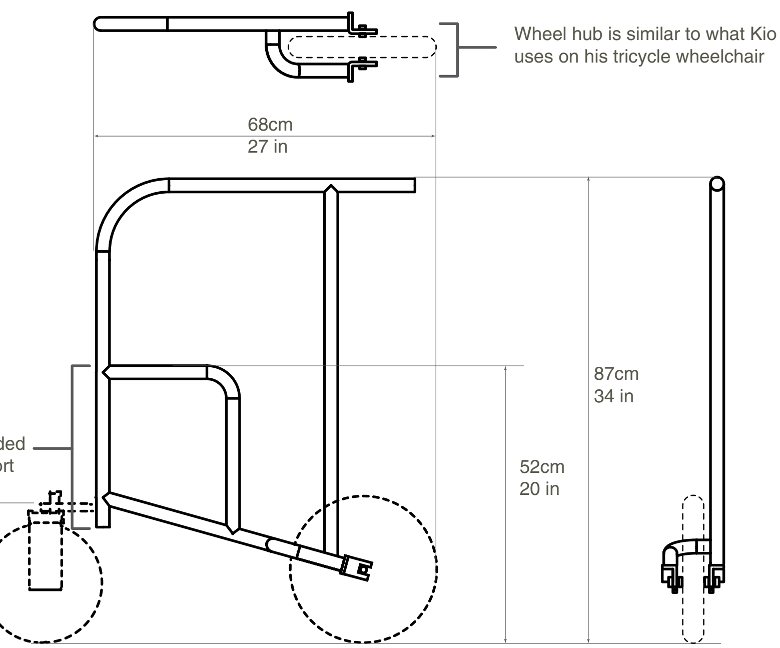
Cross-Cultural Communication

Drawings sent to Kio...





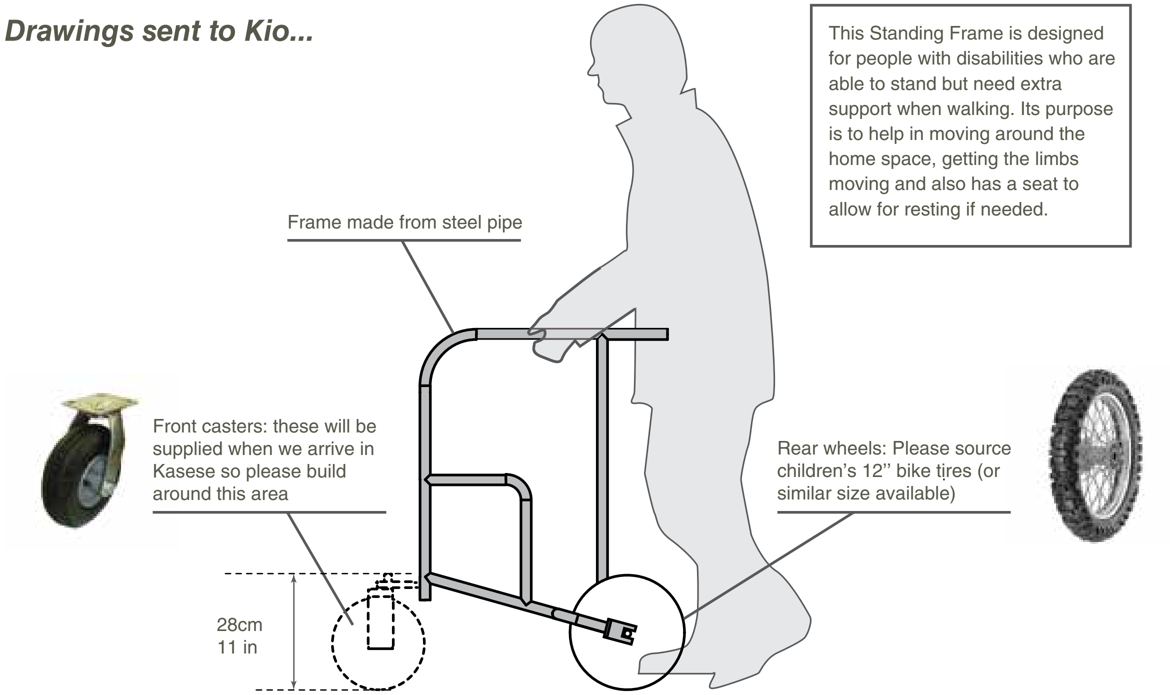


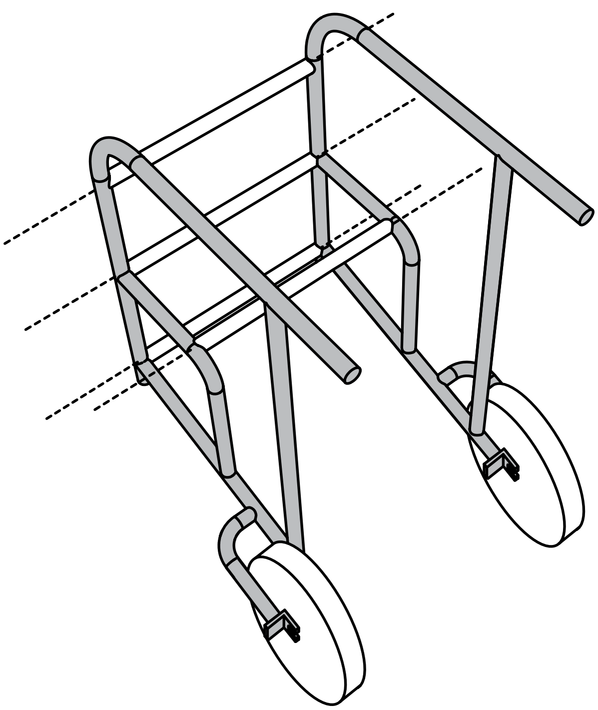


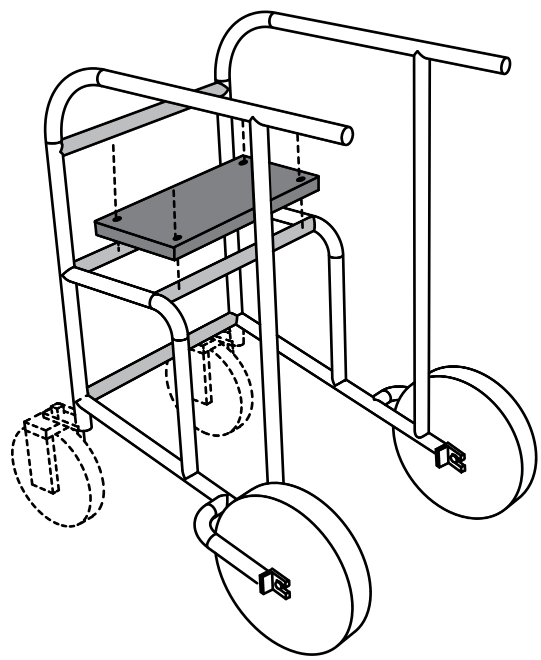
FIELD TESTING IN UGANDA

Cross-Cultural Communication

Drawings sent to Kio...







“Kio’s final model...”

> “Project development would not be possible without collaborating with Kio”

FIELD TESTING IN UGANDA

Stories from Users and Project Partners

Mukiika Kio's Manufacturing Input

Areas that Kio altered from the drawings were the handle bars and the bottom angle where the casters were to be attached. These were Kio's own inferences on how to make the design either more simple to manufacture or more comfortable and easy for the user to interact with the product.

Handle Changes

In my drawing to Kio, there is a length of pipe that extends past the frame and past where the user is supposed to hold the device. This length was only there to simplify the need for accuracy in unbent pipe length. Because I did not emphasize to Kio the reason for the length, Kio assumed that this was the area where users were to hold the device. He accentuated this fact by curving the handle downwards and adding hand grips. This affordance caused all users to hold this part of the device immediately in testing, despite the fact that this was not the intended spot and made the walker less easy to maneuver.

Frame Angle Changes

The drawings also did not emphasize that there was a critical angle in the bottom of the frame to accommodate the casters that were to be installed when we arrived in Uganda. Kio simplified the frame by removing the angle he saw as unnecessary by making it a 90° joint. Because of this, when we went to attach the casters, it ended up getting obstructed by the 90° joint and we had to re-install it by elongating the joining bar. In the end, this change became a key discovery in the process, as it turned out that an elongated wheelbase was more stable over the uneven terrain.

FIELD TESTING IN UGANDA

Stories from Users and Project Partners

Fatuma of MADE, Kampala

Kyambogo University, Kampala

Makerere University, Kampala

Katalemwa Rehabilitation Center for Children Kampala

KADUPEDI, Kasese

FIELD TESTING IN UGANDA

Stories from Users and Project Partners

Mariba Village, Kasese

Kio's Team, Kasese

Gatrida's home, Kasese

During our two week field test, we had the opportunity to meet countless helpful, people who saw the need to advocate for our cause and for people with disabilities. From communities, to individuals, the people I met all contributed to this project. Some were direct influences, and others were less so but still beneficial to the experience.

FIELD TESTING IN UGANDA

Stories from Users and Project Partners

Sibendire Augustine, Kasese

Augustine is a teacher of P6 and P7 who also suffered from polio as a child. He has to travel far to reach his school each day, and uses a long wooden cane for support when he walks. He can't travel far distances because he gets pains in his legs and he also moves very slowly and carefully.

Augustine tested both Kio's model and a European model I brought in order to compare how a foreign model can hold up in an environment that it was not designed for. Initially, he much preferred the European model because it was shiny, new, and a higher quality product. However, as he tested both, he realized that Kio's walker was sturdier over the terrain because it did not have collapsing parts. This affirmed the importance of stability over collapsibility.

Nzaibake Robin, Kasese

Robin is a hair dresser who also suffered from polio and has difficulty walking. She currently does not use an assistive device but has to move slowly and requires the help of others. Her fear of falling and injuring herself keeps her from traveling far distances.

She tested the walker after the brake system was installed and had some insight on how it could be improved. When she was trying to get out of the sitting position, she didn't have enough strength to steady herself and couldn't hold onto the brakes to keep the walker still. As there was a risk of falling involved in this process, I learned that it was important to develop a locking brake for this purpose. Some ideas were explored with Kio and further developed back in Canada.

FIELD TESTING IN UGANDA

Stories of Users and Project Partners

Kyambogo University, Kampala

At the Department of Special Needs and Rehabilitation, the student's final year project is to work together with a person with disabilities and design an assistive device for their specific conditions. When looking through their final models, I began to notice wooden frames that looked like walkers. It was interesting to see what these students were doing, as it was the opposite of what I was doing, but with the same end goal. They were trained in rehabilitation and special needs, but knew little of design, while I had the opposite skill set.

I learned the importance and need to train and fit the user to their device to ensure that it is being used properly. The device could have negative impacts if it is not the right size or is used improperly.

Biggest Insight of Field Test

A notion that was reinforced time after time, no matter who I met and talked to about mobility aide devices was the opportunity for economic empowerment. Within the Harambee group, two of the projects were specifically geared towards. Despite the fact that my project did not start out with this being a prominent objective, after the field test, it became clear that consideration of economic opportunity was very important.

In incorporating a design that could empower its users is what would make this design truly a Ugandan one. In this context, people with disabilities will use whatever means they have to create a livelihood. A mobility aide that can facilitate this as well as get them from place to place is an extremely valuable tool.

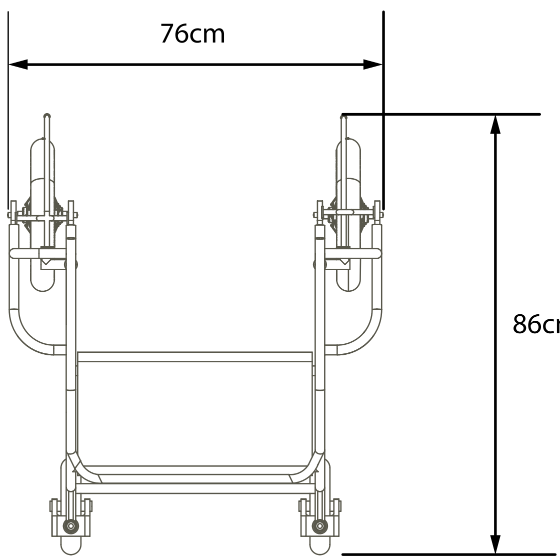
FINAL DESIGN AND DETAILS

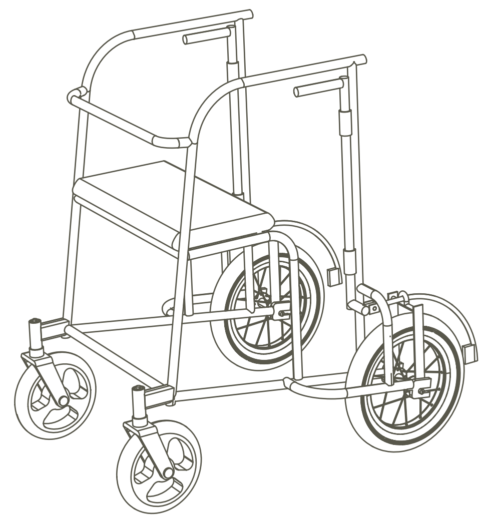
THE EXTENDED MOBILITY ROLLING WALKER

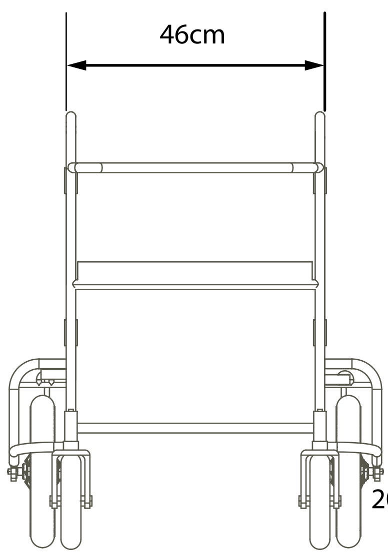
Designed and Built in Uganda

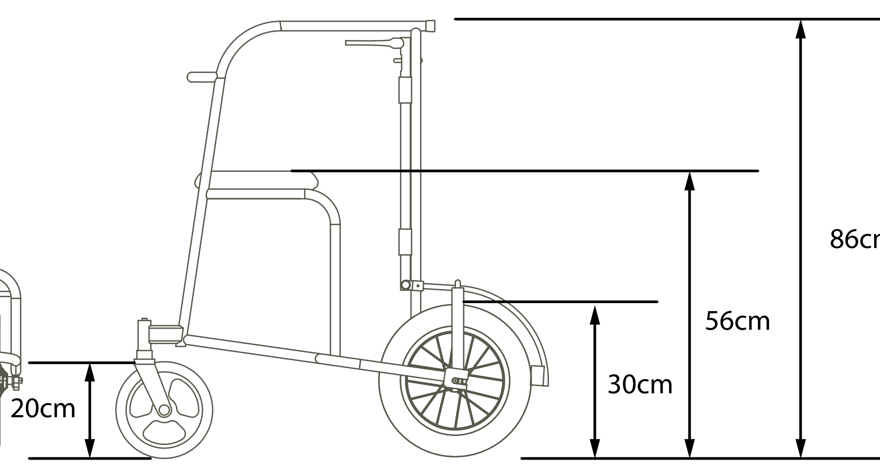
FINAL DESIGN AND DETAILS

Critical Dimension Drawings





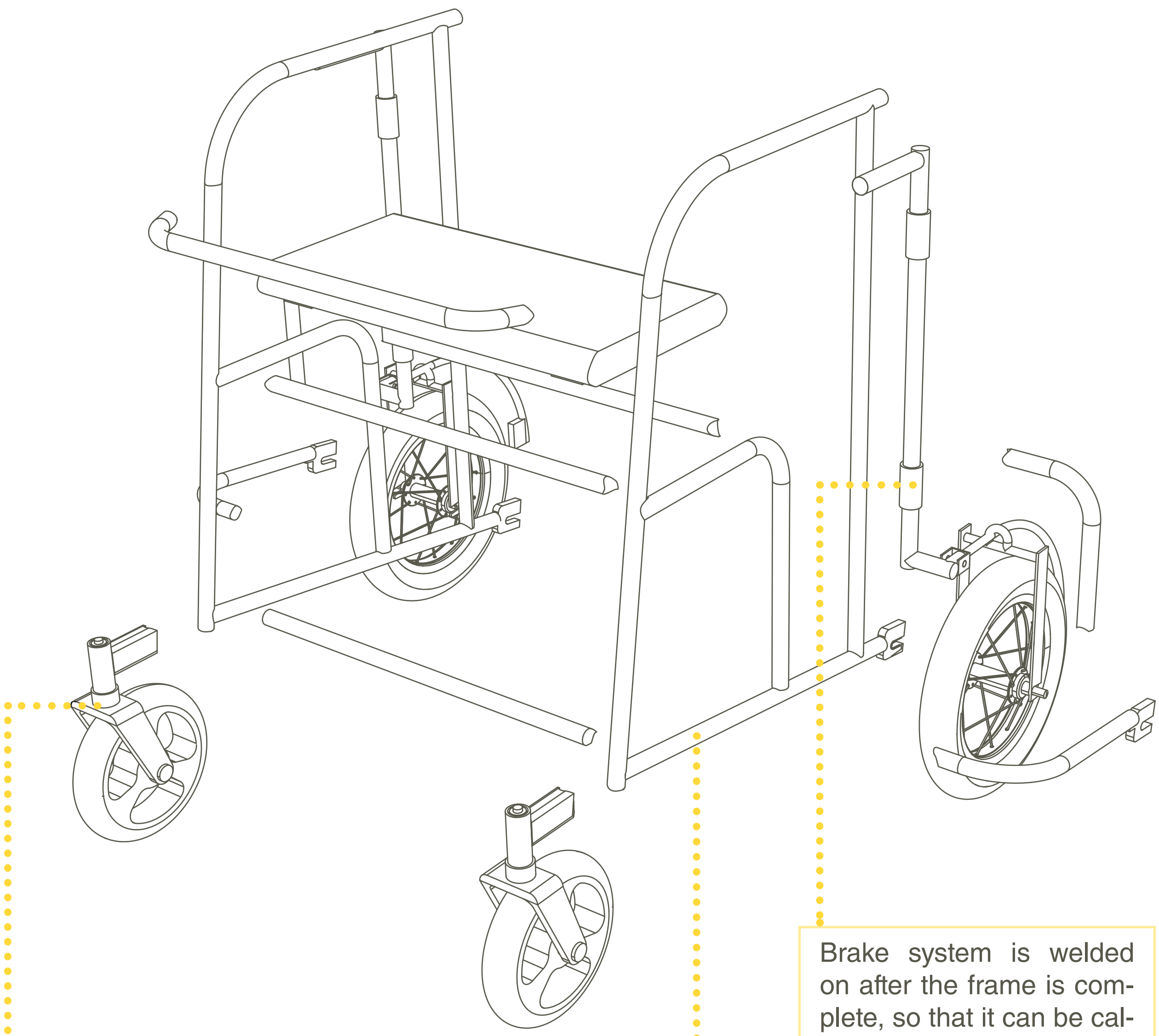




Final design dimensions are flexible, as the frame needs to be customized to the individual user. The dimensions shown are similar dimensions that were sent to Kio, with some exceptions to changes made during the field test. The final model was built from these dimensions.

FINAL DESIGN AND DETAILS

Exploded View and Components



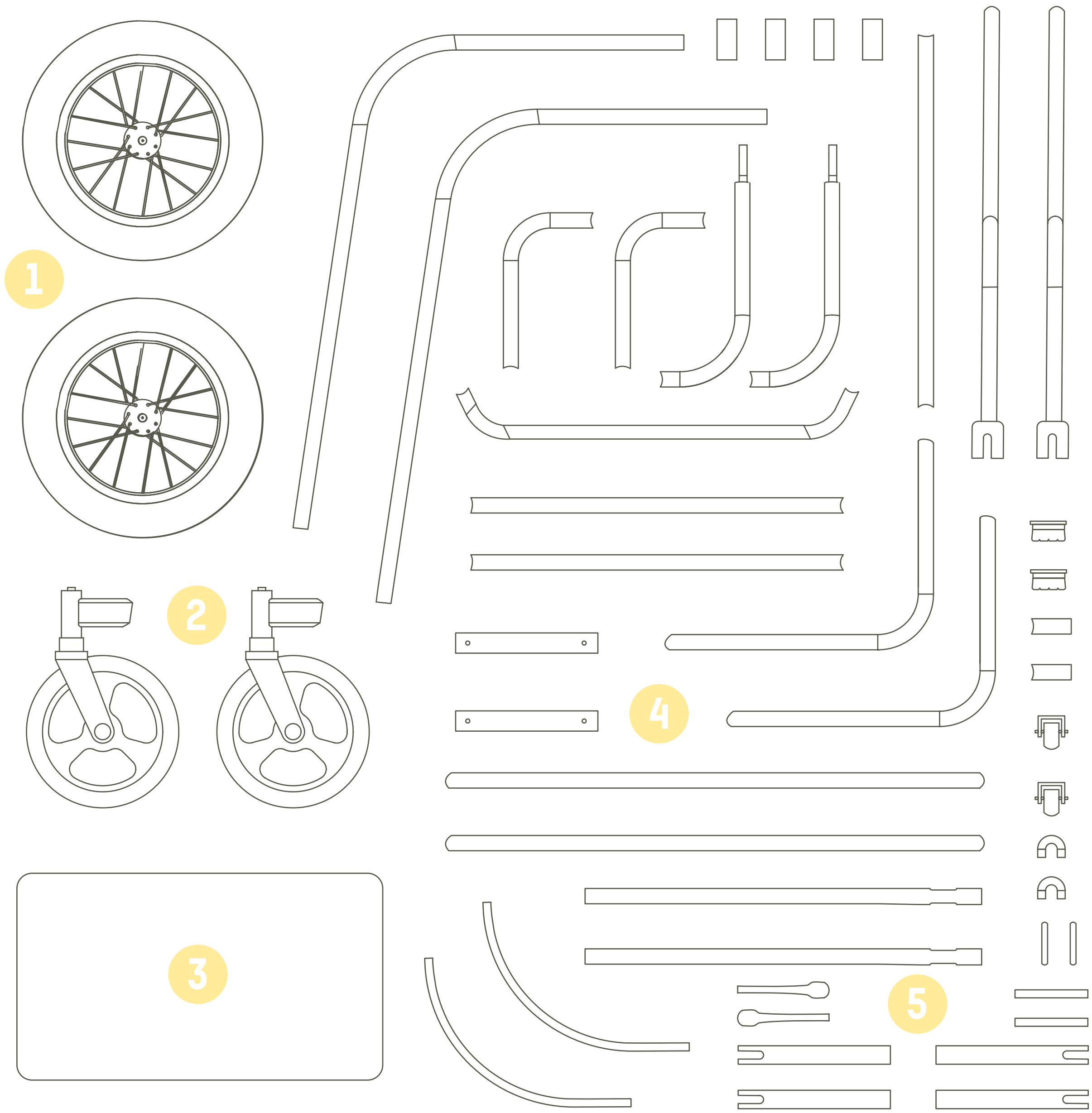
Bearing housing for casters are welded to a support bar which is then welded to the frame. Bearings and casters, supplied by a Canadian supplier, may be installed afterwards.

Brake system is welded on after the frame is complete, so that it can be calibrated to the wheel wells.

Both sides of the frame are the same and can be built in one flat plane before wheel hub and support need to be welded on, which will then differentiate the corresponding sides.

FINAL DESIGN AND DETAILS

Exploded View and Components



1. Wheels are sourced from Kampala at 70,000 USh. 2. Casters are donated from Canada, with the bearing housing fabricated from local steel round and square tubing. 3. Seat is made from wood and foam, upholstered with vinyl fabric. 4. The frame and brake system is comprised of approximately 10m of steel tubing. 5. Miscellaneous materials include brake pads, steel rods, flat steel sheets and square steel tubing.

FINAL DESIGN AND DETAILS

Features and Considerations

LOCAL MANUFACTURE

The frame can be built with the tools available to local manufacturers in Kasese

LOCAL MATERIALS

Steel and tires can be sourced locally, the casters are donated by a Canadian rolling walker manufacturer

LOW COST

The final design can be manufactured at a fraction of the cost of North American models - under $100 CAD

USER FITTED

Manufacturing methods allow for the frame to be built specifically to the user

STRUCTURAL RIGIDITY

The frame design is not collapsible so it does not compromise its strength

USER SAFETY

Slow-down and locking brakes steady the user as they move and rest

TACKLES TERRAIN

12” tires and 8” casters roll over large obstacles and uneven terrain

STABLE MOBILITY

The 1m wheelbase is more stable over terrain and easy to control when turning

ECONOMIC OPPORTUNITY

Mobility and cargo space allow for goods and services to be promoted and sold

FINAL DESIGN AND DETAILS

Features and Considerations

Brake system: Brake handle

Brake system: Brake pad arm

FINAL DESIGN AND DETAILS

Features and Considerations

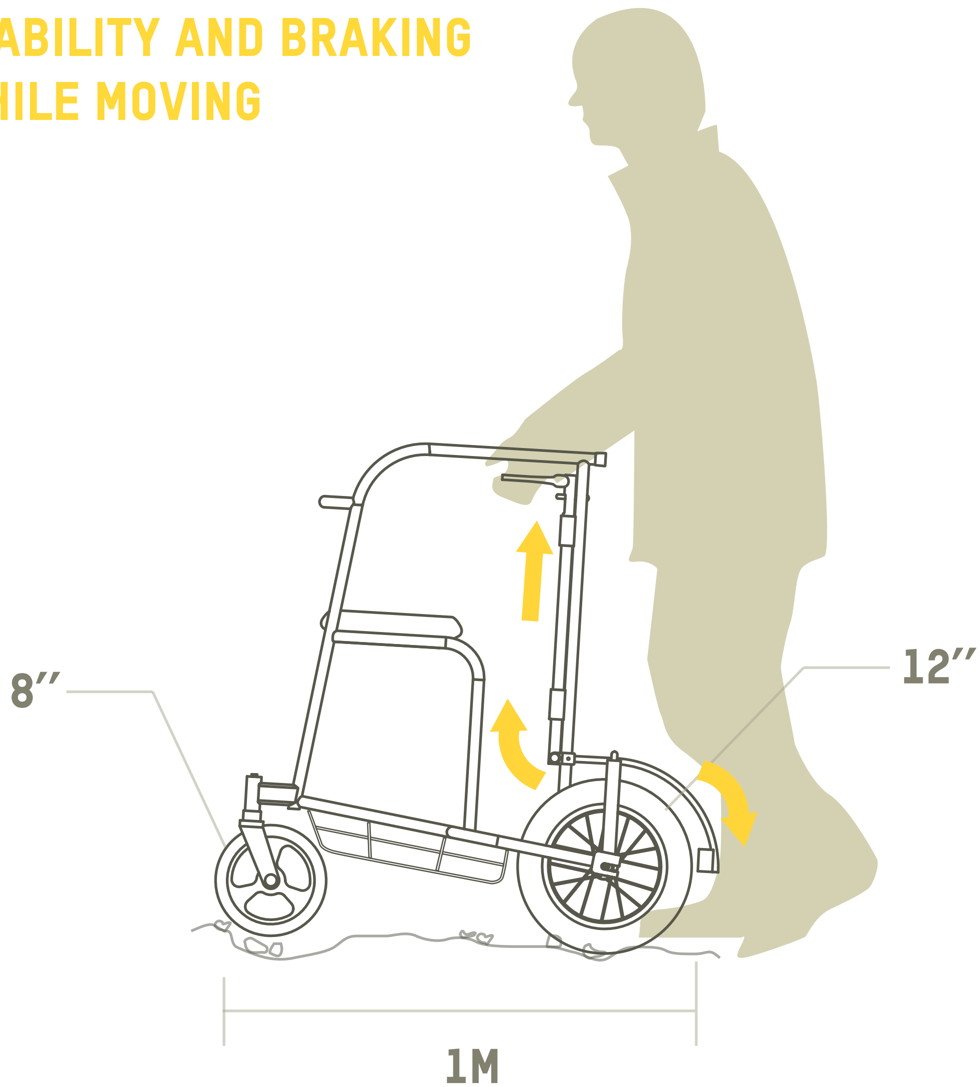
Wire mesh cargo basket

Brake system: Locking brake detail

FINAL DESIGN AND DETAILS

Use Scenarios

STABILITY AND BRAKING WHILE MOVING



Brake mechanism is engaged when the user pulls up on the handle. This triggers a series of pulling and pivoting actions throughout the brake system which allows the brake pad to come into contact with the rear wheels. Simply pulling up gently on the brake handle can slow down the device, while pulling up harder will lock the brake in place so the user may turn around to sit on the integral seat. While moving, the user can tip the walker up slightly by shifting their center of gravity on the handle so that it is easier for the device to overcome terrain obstacles.

FINAL DESIGN AND DETAILS

Use Scenarios

ECONOMIC OPPORTUNITY IN MOBILITY

There is an opportunity beyond the user's transport from A to B. Now that the user has mobility, as well as the cargo space within their device, they can use this to create economic activities. These options can range from simply selling goods that are carried in the cargo, even to services offered. For example, a hair styling business could be conducted from the device, with supplies carried in the cargo space and possibly user customizations. Through custom add-ons, there are many possibilities as to what services could be offered.


"Thank you from Team Harambee"